THREE THOUSAND YAG LASERS IN POSTERIOR CAPSULOTOMIES: AN ANALYSIS OF COMPLICATIONS AND COMPARISON TO POLISHING AND SURGICAL DISCISSIONS

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INTRODUCTION

THIS STUDY OF 3000 YAG LASER PROCEDURES FOR POSTERIOR CAPSULOTOMIES REPresents one of the largest series to be reported. Short-pulse neodymium:YAG (Nd:YAG) clinical laser systems both mode locked and Q-switched, are currently accepted as the preferred modality to traditional invasive surgery for posterior capsulotomies following extracapsular cataract extraction. Both systems were used for this report, which extended from October 1982 to October 1984. A posterior chamber intraocular lens (IOL) implant was inserted in 98.4%.

An analysis of major complications, cystoid macular edema, retinal detachment, transient elevation of intraocular pressure (IOP), and nicking of the IOL, along with the rare complications of iritis and IOL entrapment is presented. In addition, a retrospective study has been made for comparison with a series of surgical polishing and surgical discission of the posterior capsule.[1] The authors feel that this procedure has been a worthwhile advancement at a time when extracapsular cataract extraction has become the dominant technique in cataract surgery.

"In an Nd:YAG laser, the active laser medium is an Yttrium Aluminum Garnet (YAG) crystal doped with neodymium ions. In short-pulse operation, a closed shutter in the laser cavity increases energy storage in the YAG crystal prior to lasing action. Opening the shutter produces very light pulses of very high power (energy/time)."[2]

"Typical Q-switched Nd:YAG systems produce extremely short 2 to 3 nsec pulses, (1 nsec = 10^{-9} sec). Mode locked Nd:YAG systems produce

a group 'pulse train' of even shorter, 20 to 40 pica seconds (P sec) pulses (1 P sec = 10^{-12} sec)."[2]

The advantage of extracapsular cataract extraction with an intact posterior capsule over intracapsular cataract extraction as well as advantages of secondary capsulotomy over primary capsulotomy are well known. Advantages of secondary capsulotomy by YAG laser over invasive techniques are many and these will be presented in this paper.

"Short pulse Nd:YAG lasers disrupt even a transparent tissue by delivering enormous optical power to a small focal spot. The material is ionized into a fourth state of matter, ie, plasma, by stripping electrons from atoms which occupies a very small volume of space, therefore known as microplasma. This has temperatures of 10,000°C + more than twice that of the sun's surface, so it is inappropriate to refer to a photodisruptor system as a 'cool laser'."[2]

"Prevention of retinal injury in the course of a capsulotomy by the Nd:YAG laser is achieved by a beam divergence and plasma formation. Commercial ophthalmic Nd:YAG lasers broaden the laser beam with an inverse Galilean telescope and then use a moderately high power final focusing lens to achieve the desired combination of a large beam cone angle, small focal spot and comfortable working distance."[3]

A review of some of the recent reports included a study of 400 cases of YAG laser posterior capsulotomies by Johnson et al,[4] a study of 100 cases of YAG laser posterior capsulotomies by Gardner et al,[5] a series presented by Aron-Rosa[6] on the use of a pulsed pico second Nd:YAG laser in 6664 cases of which 3250 were posterior capsulotomies, and a Food and Drug Administration report on Nd:YAG lasers by Stark et al.[7]

METHODS

Patients were evaluated who presented progressive loss of vision after successful extracapsular cataract extraction surgery, due to posterior capsular haze, or wrinkling. This evaluation included a history, an ocular examination, refraction, Amsler grid, slit lamp examination of the cornea, anterior chamber, and IOL. The retroillumination technique with the Hruby lens mounted on the slit lamp was the desired method of posterior capsule evaluation. High plus-dialed direct ophthalmoscopic visualization of posterior capsule was helpful in noting the granular pattern caused by Elschnig pearls.

These patients underwent direct ophthalmoscopy when the pupil was not dilated and both direct and indirect ophthalmoscopy with dilation. Once the posterior capsule was determined to be the cause of loss of

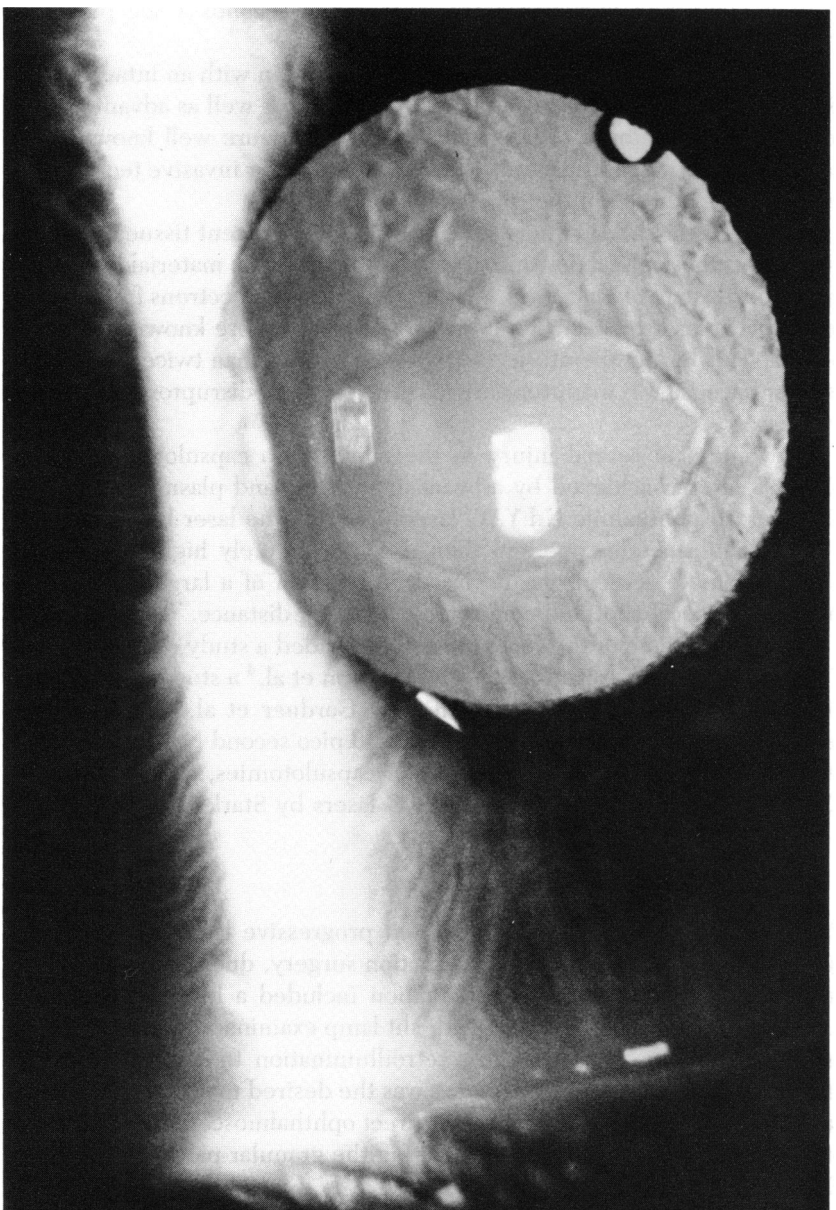

FIGURE 1
Typical laser capsulotomy being smaller than pupil and located on visual axis. Shown by retroillumination.

vision, Nd:YAG laser posterior capsulotomies were performed, 2800 with the Meditec OPL3 and Med. Laser M2000 monomode, mode locked pico second YAG laser, and 200 with the Lasers for Medicine Q-switched nano second YAG laser. Power setting and number of exposures were varied depending on the thickness of the posterior capsule. An attempt was made to keep these numbers to a minimum. The goal was to achieve an opening slightly larger than the pupil size in room light with as few exposures as possible (Fig 1).

The average power setting was 3.6 mJ on mode locked or 5.0 mJ on Q-switched. The average number of shots for the last 1000 laser capsulotomies was eight. Topical anesthesia was only used if the Abraham (Meditec 1064) contact lens was applied and only in occasional cases for an uncooperative patient and in the presence of very thick bands of posterior capsules. Dilation of the pupil, after mentally noting or drawing the optical center of capsule was the routine before capsulotomy. In the last 800 cases, dilating the pupil was found to be unnecessary with few exceptions. Capsulotomies slightly larger than the size of the pupil could be achieved by having the patient look to the four quadrants. This way, problems of having postdilation blur and having to keep in mind the optical center of the posterior capsule (PC), were avoided; this in turn reduced the number of exposures.

Follow-up care in the first 2500 cases consisted of prednisolone acetate 1%, four times a day for 1 week and acetazolamide (Diamox) 500 mg for 3 days or timolol (Timoptic) 0.5% twice daily for 3 days. In the last 500 cases, the above medications were routinely discontinued. Acetazolamide (Diamox) or timolol (Timoptic) were given only to those patients who had significant IOP rise at the 2-hour postoperative examination.

RESULTS

From a total of 3000 YAG laser capsulotomies performed, 192 cases were lost to follow-up. The following points were noted in data collection: (1) Time interval between cataract surgery and YAG capsulotomy. (2) Prelaser visual acuity. (3) Postlaser visual acuity. (4) Prelaser IOP by applanation. (5) Postlaser IOP by applanation at 2 hours and 1 week. (6) Preexisting conditions noted and categorized mainly under four headings: (A) Preexisting corneal disease, including Fuchs' dystrophy with and/or without edema and corneal haze from any other cause. (B) Previous macular conditions including macular degeneration, extensive drusen, cellophane maculopathy, and old cystoid macular edema. (C) Preexisting glaucoma. (D) Miscellaneous.

TABLE I: TIME INTERVAL CATARACT SURGERY *vs* YAG CAPSULOTOMY

TIME OF YAG POST CATARACT	NO OF EYES	PERCENTAGE
2-6 mos	253	9
6-12 mos	337	12
1-2 yrs	786	28
2-4 yrs	1123	40
4-6 yrs	225	8
6+ yrs	84	3

All surgery was performed by three individuals in approximately equal numbers.

The time interval between cataract surgery and YAG laser capsulotomy is shown in Table I (Fig 2).

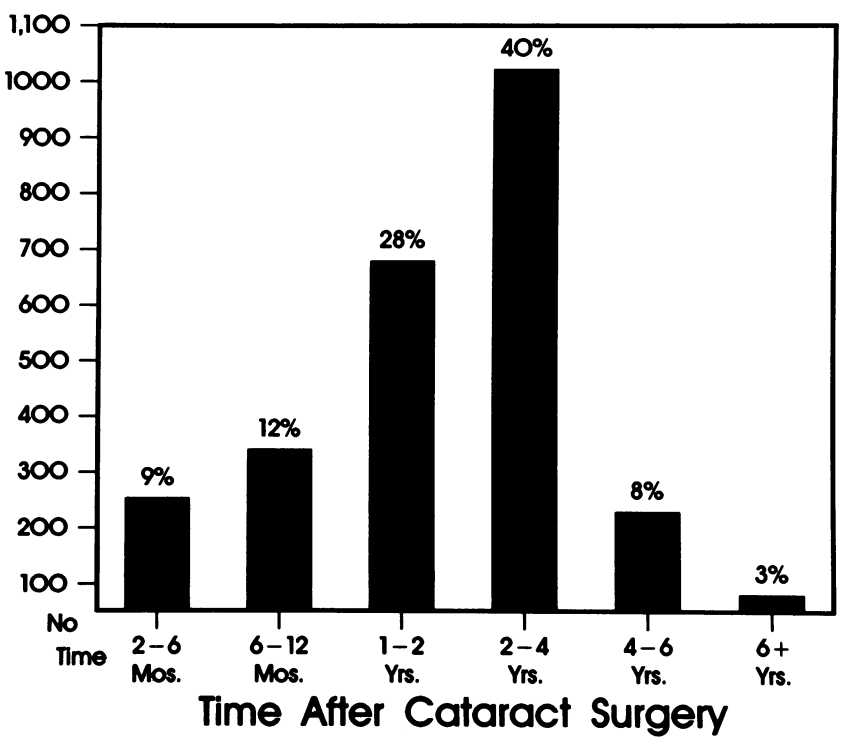

FIGURE 2
Relationship between number of eyes receiving YAG capsulotomy and time after cataract surgery.

TABLE II: VISUAL ACUITY BEFORE AND AFTER CAPSULOTOMY

	20/20	20/25	20/30	20/40	20/50	20/60	20/80	20/100 & 20/200	< 20/200
Before capsulotomy	76	301	562	657	374	217	230	177	214
Percent	2.7	10.7	20.0	23.4	13.3	7.7	8.2	6.3	7.6
After capsulotomy	922	784	500	318	124	49	51	57	3
Percent	32.9	27.9	17.8	11.3	4.4	1.7	1.8	2.0	0.1

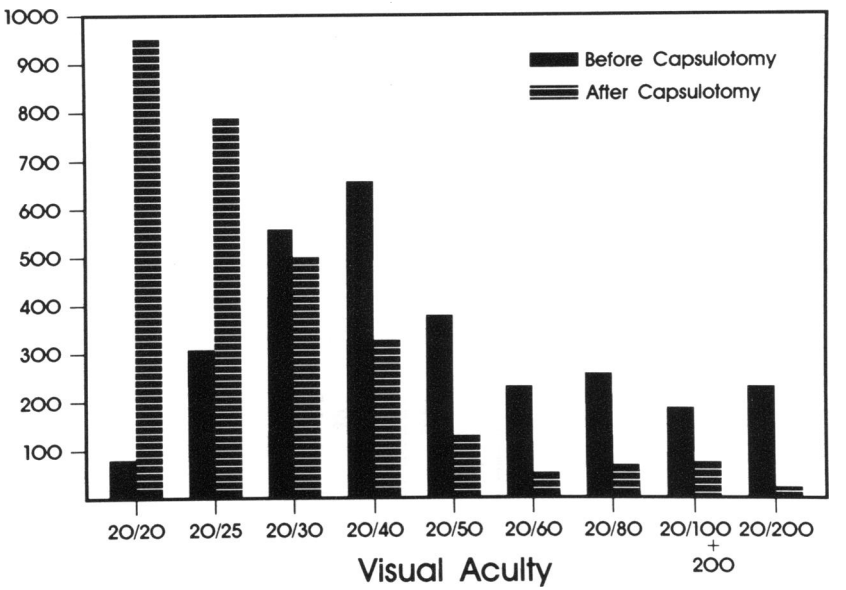

FIGURE 3
Visual acuities before and after YAG capsulotomy.

This table shows that 21% presented for capsulotomy by the end of 1 year, while 49% presented for capsulotomy by the end of 2 years, and 89% by the end of 4 years. Laser capsulotomies were required in 22% of all the extracapsular cataract extraction procedures. Table II (Fig 3) correlates the visual acuity before and after YAG capsulotomy. Almost 79% received 20/30 or better vision following the capsulotomy.

Table III records the number of cases of pressure elevations following YAG capsulotomy.

At the end of 2 hours, transient IOP elevation was found in 6.0% with no history of glaucoma and in 16.9% with history of glaucoma. At 1 week, 14.2% previously controlled glaucoma cases remained elevated *vs* 2.8% of previously normotensive individuals. An IOP of 25 mm Hg or above was used as a criteria for elevated pressure or more than 8 mm Hg rise above the prelaser IOP. Kratz[8] found this figure to be 4.2% *vs* 9.3%, although the time frame was not mentioned and 30 mm Hg was used as his elevated IOP criteria. Terry et al,[9] also noted this complication.

In the cases under study, it was noted that many of the patients had preexisting ocular abnormalities (Table IV).

TABLE III: PRESSURE ELEVATIONS

	2 HOURS	1 WEEK
Controlled glaucoma patients (148)	25 (16.9%)	21 (14.2%)
Nonglaucoma patients (2660)	159 (6.0%)	74 (2.8%)

Among these cases, the single largest category consisted of cases of macular disease, 10.9%. Corneal diseases and chronic simple angle glaucoma accounted for 3% each, all other conditions accounted for 2.18%.

Complications of YAG capsulotomy are listed in Table V and include: (1) Marks on IOL: (12%) none resulting in subjective vision loss. (2) Transient elevation of IOP: The second most common complication. A definite association with preexisting glaucoma was evident. Preexisting glaucomas were more prone to elevation of IOP as compared to patients without glaucoma is shown in Table III. (3) Cystoid macular edema: 80% of these patients showed recovery in 6 weeks to 3 months. Therapy consisted of Nalfon, 300 mg orally three times a day and prednisolone acetate 1% four times a day. (4) Retinal detachment[10]: A history of previous retinal detachment or detachment in fellow eye or high myopia, were definitely significant factors in cases who had retinal detachments (3 of 5). Two cases had vitreous prolapse in anterior chamber. (5) Hyphema: (0.15%) transient—cleared within 24 hours. (6) Iritis: Of three cases, one

TABLE IV: PREEXISTING PATHOLOGY

	%
Cornea—Fuch's dystrophy, edema or haze	3.00
Macular—macular degeneration, cellophane retinopathy, old cystoid macular edema	10.90
Glaucomas	3.33
Miscellaneous	
Myopic degeneration	0.63
Retinal degeneration including retinal pigment	0.40
Amblyopia	0.30
Old iritis	0.13
Vitreous opacities and haze	0.13
Vascular occlusions	0.03
Optic nerve (other conditions?) atrophy	0.23
Previous retinal detachment surgery	0.33

TABLE V: COMPLICATIONS

	CASES	%
Marks on IOL	337	12.00
Transient elevation of IOP	239	8.50
Cystoid macular edema	19	0.68
Retinal detachment	5	0.17
Hyphema	4	0.15
Iritis	3	0.10
IOL entrapment	3	0.10

had a history of an old iritis. Two were performed within 2 months of cataract extraction and IOL implantation. (7) IOL entrapment: (0.1%) Three cases were recorded of lens entrapment by the iris secondary to posterior capsulotomy in dilated eyes that had been associated with precipitous elevation of IOP. One required needle repositioning of IOL. The other two were repositioned with lowering of IOP and constricting the pupil. No cases of entrapment have occurred since dilation of the pupil has been abandoned.

Table VI shows a comparison of complications between surgical discissions,[1] surgical polishings,[1,11] and YAG capsulotomies.

According to this table, retinal detachments are increased if a surgical discission is performed, as well as increased cystoid macular edema. The mechanism of elevation of IOP is not easily explained. Surgical polishing alone appears to reduce the incidence of retinal detachment and cystoid macular edema.

USES OF THE LASERS

At the present time uses of the YAG laser include: (1) posterior capsulotomies; (2) peripheral iridectomy in narrow angle glaucoma, pupillary block glaucoma, and iris bombe; (3) anterior capsulotomy[12]; (4) cutting of

TABLE VI: COMPARISON OF COMPLICATIONS WITH SURGICAL DISCISSIONS AND POLISHINGS

	RETINAL DETACHMENT		CME*		ELEVATION IOP	
	CASES	%	CASES	%	CASES	%
300 Surgical discissions[1]	9	3	6	2.0	90	30
300 Surgical polishings[1,11]	0	0	2	0.6	36	12
2808 YAG lasers	5	0.17	19	0.68	239	8.5

*Cystoid macular edema.

vitreous band to the incision to reduce cystoid macular edema; (5) anterior vitreolysis; (6) cutting sutures, including McCannel sutures; (7) trabeculoplasty[13]; (8) goniotomy for congenital glaucoma[14,15]; (9) trabeculectomy revision; (10) dispersing pigmented deposits on the IOL surface; (11) sphincterotomy for updrawn pupil; (12) lysis of synechiae of retained posterior capsule fragments or cortex; and (13) weakening of haptic in dislocated IOL prior to repositioning. The future will not doubt bring many other uses.

DISCUSSION

At the present time, 80% of 700,000 cataract extractions performed yearly in this country are extracapsular and at least 20% will need a posterior capsulotomy. Contrast capsulotomies with the YAG procedure without anesthesia, taking less than 1 minute, in an office setting, with the danger of infection eliminated to a surgical discission most likely in a hospital setting under retrobulbar anesthesia.

Nicking or marks on the IOL is the most observed complication. This is confirmed by many authors with varying percentages (12% to 81%).[16] It is difficult to define this complication. Is it any opacity, regardless of size? If so, with a thorough search perhaps 100% show this finding. The important point is that none of this series showed any subjective visual loss. Many factors contribute to this result. None may be more important than the ability of the operator which becomes improved with experience.

The common finding with all inivestigators is transient elevation of IOP. Certainly, as expected preexisting glaucoma is a predisposing factor (16.9% *vs* 6.0% at 2 hours and 14.2% *vs* 2.9% at 1 week, with no history of glaucoma). Therefore, glaucoma cases should be followed carefully. Eliminating the use of steroids after YAG applications has reduced significant persistent elevation of IOP at 1 week.

The thicker the posterior capsule, the more debris is liberated and more energy is required. Dilating the pupil tends to result in a larger capsular window, due probably to uncertainty about the optical axis, causing more debris liberation. Blockage of trabecular meshwork by capsular debris, might be the cause of transient elevation of IOP.[17]

We now advocate to wait at least 3 months before doing laser capsulotomies to permit sufficient time for the posterior capsule to stretch so that fewer number of exposures may be required.

No cases of iritis in this series have occurred since eliminating prednisolone acetate prophylactically.

The incidence of retinal detachment is low. Previous retinal detachment, detachment in the fellow eye, or high myopia are contributing

factors. Disturbance of the anterior chamber vitreous phase, vitreous liquefaction and prolapse of the vitreous in the anterior chamber could be the sequence of events which predisposes to retinal detachments.[18] All patients with disturbance of the anterior vitreous and vitreous prolapse in anterior chamber should be followed closely.

All other complications amounted to slightly more than 2%. These complications have resolved without vision loss or other unwanted sequelae. If there is any relationship between mal occurrence and numbers of exposures the number of exposures has been reduced by elimination of mydriasis.

Actually, YAG laser capsulotomies and surgical polishing were quite similar. Surgical discission cases developed more complications and therefore are less favorable.

Contraindications to the YAG procedure are active cystoid macular edema and severe corneal pathology. No evidence of corneal damage was noted in this series of YAG posterior capsulotomies.

Preoperative testing to estimate visual acuity to be achieved after laser capsulotomy, and especially cases of associated retinal diseases, included potential acuity meter and the laser interferometer. A photo stress test (if cystoid macular edema is suspected) is also performed. Potential acuity meter was the primary instrument for assessment of macular function.

A small group of patients who had relatively good visual acuity but still complained of considerable visual impairment were considered for laser capsulotomy. All demonstrated a disability on glare testing.

The prelaser visual acuity is contrasted to the postlaser acuity in Table II and Fig 3. One thousand eight hundred sixty-nine cases of 67% of cases had visual acuity of 20/40 or less before laser capsulotomy. The postcapsulotomy results indicate 2206 cases or more than 78% of cases resulted in 20/30 or better visual acuity. A visual acuity of 20/20 was achieved in 922 cases or almost one-third (32.8%) while 2524 cases of 2808 had 20/40 or better (89.9%).

Certain factors should be considered in preventing complications. (1) Focusing mechanism of instrument. (2) Separation between PC and IOL. (3) Type of IOL used. (4) Power of YAG laser used. (5) Ability of operator, which becomes better with experience.

Efforts were made to compare these data to comparable series[6,7] but due to differences in data collection criteria between authors, valid comparisons were not found.

The YAG laser, in addition to eliminating the possibility of intraocular infection presents an excellent record of improved vision with minimal complications.

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DISCUSSION

DR A. EDWARD MAUMENEE. I wish to congratulate the authors on this study of 3000 YAG laser procedures for posterior capsulotomy. In the past I have been involved in several studies in which we have attempted to obtain a follow-up study on patients whom have had some type of therapeutic procedure. I can assure you this is a most difficult task. The authors are to be congratulated on obtaining a 94% follow-up on such a large number of patients.

I agree with the authors' indications for use of the YAG laser and I also find that their results are comparable to those that we have observed after treatment with this modality at the Wilmer Institute.

I note that 98.4% of the patients on whom the YAG laser was used had had posterior chamber intraocular lens implantation. I, therefore, am a little surprised that five of these patients developed retinal detachments and in two of these cases there was a prolapse of vitreous into the anterior chamber following therapy. I have experienced retinal detachment in at least one patient shortly after I did a YAG capsulotomy when vitreous prolapsed into the anterior chamber. However, that patient did not have a posterior lens implant.

Some of the audience might question the use of the YAG laser in patients who have 20/20 to 20/25 vision but on occasion, radiating folds can be produced in a clear posterior capsule and even though the patient can see 20/20 to 20/25 they are very annoyed with the Maddox Rod effect from these radiating folds which produce unpleasant streaks on the retina. These individuals are relieved when the posterior capsule is eliminated with the YAG laser.

I note that the authors obtained satisfactory openings in the posterior capsule with only an average of eight bursts of the YAG laser. It has been my experience that heavy opacification of the posterior capsule and opacification by epithelial pearls requires considerably more bursts sometimnes up to 100 to obtain an adequate opening in the capsule. However, I usually use either 1 or 2 mJ rather than the 3.6 to 5 mJ used by the authors.

Finally, I wish to refer to a paper presented at the last Academy Meeting by Doctor Arlo C. Terry entitled "Toxicity of Laser Damaged Intraocular Lens Implants" (*Ophthalmology* 1985; 92:414-418). It was widely quoted that he had found pitting of injected molded lenses when hit with the YAG laser in tissue culture fluid produced a toxic substance which would kill cells when placed in the supernatant fluid indicating that some toxicity had been liberated from the injected molded lenses, whereas such toxicity was not found from lathe cut lenses. Doctor Terry was very careful to state that the millijoule power used in this study was far above the level used for clinical therapy. He also stated that, "the loss of toxicity observed after storage of the supernatant for 72 hours appears significant. Since plastic monomers are thought to be stable for long periods, we may be observing the toxic effect of the breakdown of other products. The residual toxicity in stored supernatants may represent that to monomers." The injected molded lenses that he had used were believed to be discards by the manufacturer so that in an addendum to his paper he repeated the study with lenses that were sent out for clinical use. In this second study 10 mJ had to be used on the YAG laser to produce a slight toxicity, that is 20% cell death with choroidal and retinal blastoma cells. Thus it would appear from Doctor Terry's study that the clinical level of energy that is used with the YAG laser does not produce any toxic effects even when injected molded or lathe cut intraocular lenses are pitted.

DR WALTER J. STARK. First, let me congratulate the authors on the number of YAG laser cases reported, the extent of follow-up, and the low loss to follow-up rate.

Certainly, the posterior capsule will be a problem in the United States; our most recent figures through the FDA indicate that 820,000 implants were performed during the last 12 months (February 1984 through February 1985) and 79% of these received a posterior chamber lens. Figures indicate a large number of patients with posterior chamber lenses and most of these will have the posterior capsule left intact.

Doctor Gills has reported an extensive number of cases. We recently reported some 20,000 YAG laser capsulotomies from the Food and Drug Administration and found essentially the same problems as discussed. I pose the following questions. First, we found the most common problem to be elevation of intraocular pressure. This problem occurred in a varying percentage of cases; up to 30% of patients had a 5 to 10 mm Hg pressure rise, but 3% to 4% of the patients had a pressure rise greater than 30 mm Hg. Some patients had a pressure rise to greater than 40 to 50 mm Hg. This occurred in the 2 to 5 hour range, but was most frequent at about 2½ hours after YAG laser treatment. I am interested in knowing if their patients were checked 2 to 5 hours after laser treatment.

Second, the damage to the intraocular lens (IOL) occurs in about 15% to 25% of cases depending on the reviewed series indicating, I think, that the quality of the instrument is just as important as the operator. I am interested in knowing which instruments were used because a fairly low rate of damage to the posterior chamber lens is reported. For some machines, I think the quality is poor enough that one just cannot focus accurately. Also, I would like indicated whether you have had experience with reversed optic lenses. We recently had a problem treating patients with reversed optic lenses that led to considerable laser damage to the IOL. Doctor William Bourne, of the Mayo Clinic, has indicated personally that he has experienced the same problem with pitting or nicking reversed optics IOLs which differ from conventional IOLs.

Another problem in need of further clarification is anterior hyaloid face rupture. We find that at least 50% of those patients without an IOL in place will experience rupture of the anterior hyaloid face. This usually does not occur on the first shot but will on the second shot. You indicate the use of higher laser energy per shot than we do. We use 1 to 1½ mJ as Doctor Maumenee indicated; I notice that you use 5 mJ. I question whether perhaps one or two blasts with a higher energy might avoid rupture of the vitreous as opposed to multiple shots of lower energy.

Finally, your visual acuity slide was presented very quickly. It is important to know how many patients have 20/40 or better visual acuity. More importantly, however, I wish to know how many of the patients with 20/40 or better visual acuity before treatment dropped to less than 20/40 after treatment. In fact, that's one of the questions we posed at the Food and Drug Administration. There appears to be a 4% to 6% chance that a patient will have reduced visual acuity with the YAG laser procedure in these 20,000 cases that we have reviewed; this factor is probably the most important point. I would like you to address this point because if we see patients with 20/20, 20/25, or 20/30 visual acuity and a little haze to the capsule and possibly a little glare, we need to tell those patients from our

experience that there is about a 5% chance they will have a reduction in visual acuity from the YAG laser procedure.

DR DANIEL M. TAYLOR. I would like to congratulate Doctor Durham and Doctor Gills. The size of their series is staggering. Our own experience is relatively small and would total some 400 capsulotomies. We have tried to stay with a power setting of between 1.2 and 1.7 mJ and usually can produce an adequate opening with some 5 to 10 exposures. As far as complications go, I have found utilization of the YAG laser to be a rather inocuous procedure. We have had one retinal detachment that occurred shortly after a YAG laser posterior capsulotomy in an eye with a posterior chamber intraocular lens. I would like to hear the authors comment more about retinal detachment, following use of a YAG laser, as I have heard of several similar isolated instances of detachment. We have had only one or two cystoid macular edemas as the result of YAG laser posterior capsular capsulotomies and we have had several transient elevations in pressure. None of the latter proved to be persistent. There were no instances of significant iritis. We have managed to pit a few lenses early in our experience, but this has become rather infrequent, unless the patient suddenly moves. In the future I believe that the YAG laser will be used with great frequency. With 6 years of experience with extracapsular surgery I am aware of an ever increasing number of patients who suffer a significant deterioration of visual acuity some 2 years after extracapsular surgery due to secondary opacification of the posterior capsule. Our initial results of 20/20 to 20/25 gradually slide to 20/40 or less and are accompanied by glare. It is my present opinion that a majority of all eyes that have received an extracapsular cataract extraction, no matter how meticulously performed, will ultimately require a posterior capsulotomy to restore optimum vision.

DR RICHARD C. TROUTMAN. We have been privileged, or you might say unprivileged, to have a laser that is shared by multiple surgeons; in fact, in 1 year, we have 180 ophthalmic surgeons who use it. The problem of maintaining its accuracy is very demanding. We have had to require that each surgeon bring in his or her own contact lenses because they not only pit the intraocular lens but the contact lenses as well.

The second point that I'd like to ask the authors about is the advantage, if any, of the laser ridge. We have heard a lot of advertising about this feature. I have heard also from various people, and from my own personal experience, determined that laser ridge can be a definite disadvantage. The capsule tends to follow around it and against the back of the lens to coat the lens more firmly than when no laser ridge is present.

The third point, is the size of the opening made. I have a number of patients who have complained, after the laser capsulotomy which we have supposedly placed exactly in the middle of the optical axis and made the size of the constricted pupil, that on night driving with headlights coming toward them or looking at street lights, they have experienced diffusion of light and/or colored lights. We have repeated several cases enlarging the opening. In one of those patients I had a

retinal detachment. I would like to know the author's experience with repeated laser capsulotomy—whether or not the repetition of the laser capsulotomy has been a problem, whether there is an increased incidence of complications when a second or even a third capsulotomy has to be done.

The last point I would like to make concerns the incidence of glaucoma. I feel that 2 hours and 1 week following capsulotomy is not a correct time interval. We have had patients call in the middle of the night after capsulotomy with severe ocular pain from severe rise in pressure. We had given them acetazolamide and timolol to take at home. We have used steroids but I think I will try your suggestion and discontinue the use of steroids. The intraocular pressure elevation can occur at any time during the 1-week postoperative period and even beyond. We have had some of them persist, especially in anterior segment reconstruction where we use a lot more energy, well beyond the 1 week level.

Dr Thomas Wood. At meetings where the YAG laser is discussed, one of the primary complications that is talked about is the acute elevation of intraocular pressure. I'm wondering if there is any evidence that this transient rise in pressure produces damage. For many years, I was interested in the intraocular pressure rise following aphakic transplant, as well as cataract procedures. Over 1 year's period of time, we monitored the intraocular pressure in corneal transplants in Gainesveille. When I examined our data, the pressure curve was no different in the treated eyes versus the nontreated eyes. A few years later, we examined the initial intraocular pressure response in eyes undergoing extracapsular cataract procedures with posterior chamber lenses. We treated patients with timolol and had a nontreated control group. We found that the pressure curve was identical whether we treated the eyes or not.

Another observation concerns lens placement. For several years, I inserted implants in the posterior chamber with the convex side posterior. About 3 years ago, I began inserting the lens convex anterior. Few of the eyes that I placed the lens in convex posterior have required a posterior capsulotomy; whereas, in eyes with the lenses convex anterior, about 20% required a posterior capsulotomy 1 to 2 years after surgery.

Dr William Tasman. I would like to add my congratulations to the authors for reporting this very large series. I can't tell you how many YAG laser capsulotomies have been done at our institution but we have recently seen somewhere between four and six retinal detachments in the last few months. I think in this era of decreasing incidence of retinal detachments following cataract surgery the retinal surgeon may have found a new friend in the YAG laser. My question to the authors, however, is were any of the eyes that developed detachment, predisposed to detachment? For example, did any eye have lattice degeneration or retinal breaks and along the lines of the question asked by Doctor Troutman, was there an increased number of laser applications in those patients who developed retinal detachment?

DR JAMES P. GILLS. Thank you for your excellent discussion. First, I would like to look at the problem of retinal detachments that Doctor Tasman has discussed. Out of these patients, three had predisposing factors, two having previous retinal detachments, and one a hig myope. So, out of the five detachments, three had predisposing factors which may influence this statistic somewhat. If these three patients were removed from the data, the rate of detachment would be near that expected per thousand in this age group.

In regard to the intraocular pressure, I think Doctor Wood is correct. It may not make any difference whether we treat these pressure elevations or not. We now that by stopping the use of steroids prophylactically after capsulotomies, we have dramatically reduced the number of pressure elevations at 1 week following posterior capsulotomy. We have, however, treated all our early pressure elevations following laser capsulotomy and have no experience with untreated early pressure elevations.

Doctor Taylor, in his discussion of retinal detachments, mentioned out rate of YAG capsulotomies following extracapsular cataract extraction. To clarify this, I would like to say we had an over-all incidence of 22% capsulotomies following our cases for 4 years. But, please remember this is a large group of patients extending back more than 10 years. If we look at capsulotomies following extracapsular cataract extractions on a yearly basis, we see about a 3.5% rate per year.

The Troutman experience with pitting incidents falling with experience is something we have also observed. I don't have as much experience doing YAG laser posterior capsulotomies as my medical associates. I have a pitting rate of about 20% and theirs is about 11% or 12%. They do have a significantly larger volume of the YAG laser posterior capsulotomies. Pitting, as Doctor Wood mentioned, may in part be related to the type of lens and its placement. We use a 3M lens with the curved surface posteriorly placed, and we do have a high incidence of nicking with this lens. The curved surface of this lens is pressed against the capsule which certainly should increase the likelihood of nicking. Unfortunately, we don't have the statistics whether there are fewer capsular cloudings using this one lens technique with the curved surface posterior. I think the optics of the slit lamp of the laser is also an important factor in pitting.

As Doctor Troutman pointed out the size of the capsular opening is important. We have had to enlarge several openings to achieve satisfactory visual improvements. In these cases we have had no complicàtions. Since we have stopped dilating pupils before posterior capsulotomies, we have been able to more precisely outline the capsulotomy needed.

As we have not used the laser ridge lens, I can't really make any statement about that.

Patients with better than 20/40 vision following extracapsular cataract extraction and intraocular lens implantation and a great deal of complaint of either blur or glare, have been done by us. This is after the disability is demonstrated with a glare test that often shows disability in glare of more than 20/100. Patients with demonstrable glare disabilities who have received posterior capsulotomies have demonstrated a high degree of satisfaction. We have reached the 8 shot average

because our people do four or five capsulotomies a day on machines they are familiar with. We have used three machines which we like equally; the Medical Lasers M-Tech 2000, Lasers for Medicine Phototome 2700, and more recently the new Zeiss Q-Switched YAG. The Lasers for Medicine machine has a nice focusing system, but it does require some getting used to. The Medical Lasers 2000 mode lock is a reliable old friend. We have been completely satisfied with the Zeiss in a somewhat shorter experience. Our follow-up has been virtually the same with all these machines. We are seeing the patients 2 to 5 hours postoperatively and at about 1 week following the procedure. When the laser follow-up documentation studies have been completed, we plan to follow the patients about 6 months after the procedure and then return to our normal patient follow-up routine.